Thesis/
Reports
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Sept. 29, 1987

Director
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Dear Sir:

Enclosed please find a copy of a report entitled, "A Standard Procedure for Experimental Trampling of Vegetation". This report is submitted in fulfillment of Item II I of Cooperative Agreement No. 22-C-5-INT-35 Amendment #2. This is the final item in the agreement to be completed and the final billing will be submitted shortly.

A copy of this report has been forwarded to Dr. Robert Lucas (ADODR). Thank you for your support of this project. It has resolved a number of issues and pointed the way toward high priority research for the future.

Sincerely,

David Cole

David N. Cole

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INTERMOUNTAIN
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A STANDARD PROCEDURE FOR EXPERIMENTAL TRAMPLING OF VEGETATION

September 1987

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OCT 2 1987

INTERMOUNTAIN
RESEARCH STATION

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In partial fulfillment of Cooperative Agreement No. 22-C-5-INT-035

INTRODUCTION

Experiments that examine the response of vegetation to controlled levels of trampling have frequently been used in the field of recreation ecology. This method is virtually the only way to control most of the variables that influence vegetational responses to trampling. While much has been learned from such studies, it is difficult to make generalizations because methods used have generally been incomparable. Refer to Cole (1985) for a review of experimental trampling studies and problems created by the use of dissimilar techniques.

This paper proposes a standard experimental trampling procedure designed to optimize efficiency of space and time. It is considered to be effective in addressing some of the most important questions of concern in experimental trampling studies.

Trampling studies have been used to study initial responses to trampling, responses to prolonged trampling, and the recovery of trampled sites, after trampling has been curtailed. As discussed in Cole (in press), there are problems with the use of experimental trampling to study the response of vegetation to prolonged trampling and subsequent recovery. Vegetation recovery on trampled lanes occurs much more rapidly than on recreation sites because vegetation can readily spread from undisturbed buffer strips to adjacent trampled lanes. Moreover, it appears that trampling must continue for more than several years before the capacity to recover reaches a stable minimum. Closure of existing recreation sites--while replete with its own set of problems--seems a more appropriate means to study recovery of long-used recreation sites.

Prolonged use of almost any site, except at low use intensities, will eliminate most of the vegetation. Therefore, there seems to be little value in trying to assess the ability of vegetation to survive prolonged trampling. Site durability, where use is prolonged, will usually be related more to soil characteristics than vegetation characteristics. The impacts of most concern where recreational use is prolonged can be studied in an experimental manner, but control and stratification of variables such as soil moisture, soil texture, and slope are usually more important than vegetation type (although vegetation may be correlated with these variables). This calls for either very different types of experiments (beyond the scope of this paper) or studies that monitor changes on recently opened recreation sites.

Experimental trampling of different vegetation types seems to be most useful in examining short-term effects and subsequent recovery following relatively light trampling. Differences among vegetation types in vegetation loss are most pronounced at moderately light trampling intensities (100 to 300 passes/year) and after just one season of trampling (Cole in press). This type of trampling simulates the effects of various levels of dispersed trampling. This would be most applicable to understanding the response of vegetation to off-trail travel or infrequent use of poorly-defined campsites.

An improved understanding of the relative durability of different vegetation types and the levels of use beyond which well-defined trails and campsites are likely to develop, can contribute substantially to improved recreation management. Managers can use the information in deciding between dispersal and concentration strategies for use distribution, in setting use limits and in deciding where "official" trails need to be constructed. Perhaps of more importance, information on the durability of different vegetation types can be conveyed to visitors, in hopes that they will seek out durable routes and campsites. Education of this type can also be used by visitors when deciding whether to use existing campsites or pristine sites.

A STANDARD PROCEDURE

The suggested procedure that follows has been refined over many years of experimental trampling, reflecting research in a variety of vegetation types. It is the result of collaboration between myself and Dr. Neil Bayfield, plant ecologist with the Institute of Terrestrial Ecology, working in Scotland. It has been designed to provide the most information in a relatively short period of time and a relatively small sample area. It also has the aim of providing comparable results when undertaken by different investigators.

Four specific objectives of the procedure are:

(1) to provide measures of vegetation response to several common levels of trampling;

(2) to estimate the level of trampling required to reduce vegetation cover by 50%;

(3) to estimate the level of trampling required to reduce mean vegetation height by 50%; and

(4) to provide measures of recovery, over a one-year period, from each of these common levels of trampling and vegetation damage.

Plot Design and Treatments

In each vegetation type to be examined, establish four replications of the experiment. Each replication consists of five lanes, delineated by stakes (for example, PVC pipe). Lanes should be 0.5 m wide and 1.5 m long. Each lane should be separated by a buffer at least 0.4 m wide. If all five lanes can be located side-by-side, as in figure 1, each replication requires a 1.5 m by 4.1 m area. If lanes are located end-to-end, it is important that an area of at least 0.5 m be left between lanes for turning (fig. 2). Lanes should be established as close to each other as possible and out-of-the-way, where they are unlikely to be disturbed. They should be as flat as possible and, where not flat, oriented so that their long axis parallels contours. The groundcover should be relatively homogeneous in density and composition of the vegetation. If composition is not homogeneous, at least the relative cover of different growth forms should not be greatly dissimilar. Downed logs and rocks should not be present. Replications need not be located adjacent to each other, but they should be established within the same vegetation type (that is, the floristic and physiognomic composition of the undergrowth should be similar).

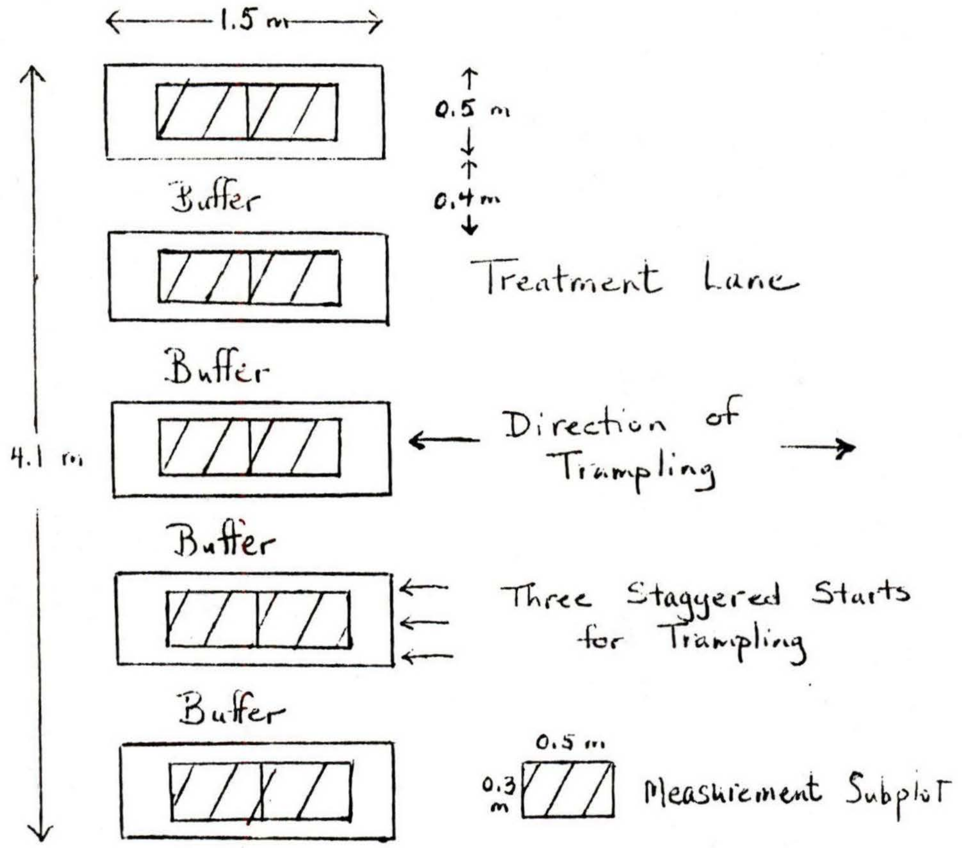

Figure 1. Layout of treatment lanes, buffers and measurement subplots within treatment lanes.

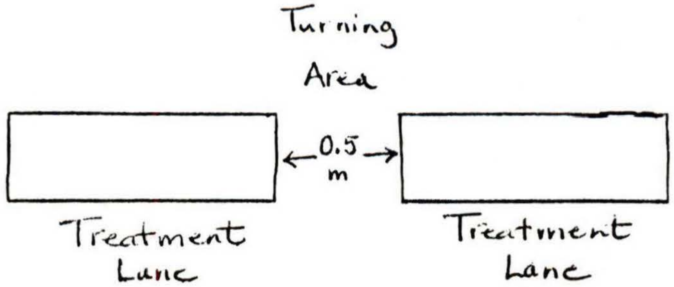

Figure 2. Turning area required when treatment lanes are located end-to-end.

Each lane should be randomly assigned a separate treatment. These treatments include the control lane, which receives no trampling, and lanes that receive 25, 75, 200 and 500 passes. A pass is a one-way walk at a natural gait down the lane. The trampler should stagger starts from three locations across the width of the 0.5-m-wide lane, so that the entire width of the lane is trampled uniformly (fig.1). The direction and precise location of turning (between passes) should be varied so that locations along the length of the lane are trampled uniformly. Turning should always occur beyond the lanes. Trampling should be conducted at approximately the same time for all treatments and replications. Ideally, it should be conducted between the spring flush of vegetative growth and the onset of reproduction. At this time, vegetation cover is at a maximum, while the ability for immediate regrowth, following trampling, is reduced.

At this time we cannot accurately predict differences in the response caused by tramplers of differing weight or wearing different types of shoe. Preliminary results (to be reported elsewhere) suggest that differences are neither large nor consistent. If so, then standardizing weight and shoe type may not be critical. Nevertheless, until results are more conclusive it would be best to utilize tramplers of moderate weight (175 to 190 lb) and to wear boots with lug soles. Lighter tramplers can simply wear a pack to increase their weight.

In extremely resistant vegetation types, where 500 passes have little effect on the vegetation, treatments must be modified to obtain an estimate of use levels required to cause substantial damage. If it appears that 500 passes will not eliminate 50% of the vegetation cover (within two weeks after trampling occurs), then the 25 pass lane should be trampled until it appears that a 50% loss will occur. This number of passes should be repeated on all replications. This procedure maintains as much comparability as possible, while allowing comparison of the use levels that cause a comparable level of damage.

Measurements

A series of measurements will be taken on each lane, both before and after trampling. Take measurements on two 30 cm by 50 cm subplots located adjacent to each other, with long axis parallel to the long axis of the lanes, 0.25 m from each end of the lane (fig. 1). Parameters to be measured are:

1) An ocular estimate of the canopy coverage of each vascular plant species and of mosses and lichens, each as a group. Generally, only green photosynthetic material should be included in cover estimates. For example, do not include surviving stems that have been defoliated by trampling. Record cover as 0 if there is no cover or as the closest of the following values: 0.5, 2, 5, 10, 15, 20, 30, 40, 50, 60, 70, 80, 90 or 100%.

Where plants are tall, a number of problems may result because plants may be rooted in one lane, but provide canopy cover in another. This can lead, for example, to loss of cover on a control, because a plant, rooted elsewhere, dies following trampling. Alternatively, cover may increase because a plant is knocked into a lane from which it was initially absent. Where these problems are likely, it is probably best to only consider the cover of plants rooted in the lane and ignore the cover of plants that merely hang over the lane. Because this is a rather artificial procedure, it should be avoided except where necessary.

2) An ocular estimate of the coverage of bare ground, ground not covered by live vegetation. Bare ground can be either mineral soil or soil covered by organic horizons, including the litter of recently trampled plants. Use the same cover values as for species cover.

3) Measures of vegetation height. Drop a frame with 5 pins (3 mm in diameter), located 5 cm apart, across the 30 cm width of the subplot. Drop the frame systematically, 10 times along the length of the subplot. Push the pins down to the ground surface and record the height of the tallest live plant contacting each pin. If no live vegetation is contacted record a 0; if the tallest plant is < 2.5 cm tall, record 1.25. Otherwise record the closest value in increments of 5 cm (5 cm, 10 cm, 15 cm, etc.).

A complete set of measurements, two subplots per lane, should be taken immediately before trampling. Immediately after trampling, height measurements should be taken on all subplots, except for those on controls. About two weeks after trampling, vegetation cover and bare ground estimates should be taken on all subplots. One year after trampling, all measurements should be repeated on all subplots.

Data Analysis

For bare ground, species cover (the sum of the percent covers of all species on each subplot), and vascular species cover (the sum of the percent covers of all vascular species on each subplot), calculate the mean of the two subplots in each lane, at each measurement point. Using the bare ground means, calculate relative bare ground, by determining the increase in bare ground on treatment lanes (post-trampling bare ground minus pre-trampling bare ground) and subtracting from this any increase in bare ground on controls (post-treatment bare ground minus pre-treatment bare ground). The formula is:

$$\text{Relative bare ground} = (AT - BT) - (AC - BC),$$

where AT, BT, AC and BC are bare ground means after (A) and before (B) treatments on trampled lanes (T) and controls (C).

Calculate relative species cover and relative vascular species cover, using the following formula:

$$\text{Relative cover} = \left(\frac{\text{post-treatment cover on trampled plots}}{\text{pre-treatment cover on trampled plots}} \times \text{cf}\right) \times 100\%,$$

$$\text{where cf} = \frac{\text{pre-treatment cover on control plots}}{\text{post-treatment cover on control plots}} .$$

and cover is species cover and vascular species cover. For abundant and widespread species, it is also possible to perform similar analyses for individual species, by substituting cover values for individual species.

Calculate mean vegetation height by summing the heights for the 100 pins dropped in the two subplots on each lane and dividing this sum by the number of non-zero values. Caculate relative height using the following formula:

$$\text{Relative height} = \left(\frac{\text{post-treatment height on trampled plots}}{\text{pre-treatment height on trampled plots}} \text{ X cf} \right) \text{ X } 100\%,$$

$$\text{where cf} = \frac{\text{pre-treatment height on control plots}}{\text{post-treatment height on control plots}} .$$

Calculate relative bare ground, species cover, vascular species cover, and height for each lane for each measurement point following trampling. Disregard values for controls, which by definition should be approximately 100%. For each parameter, this should provide four measures of vegetation response to trampling (differing in number of passes), for each replication. Observations immediately after trampling (for height measures) and two weeks after trampling (for cover measures) provide measures of deterioration. Observations a year after trampling, provide measures of recovery over a one-year period and the loss that would be cumulative should trampling occur year after year.

Characterization of the Vegetation Type

It is important to characterize the vegetation type in enough detail to communicate its nature to others. Placing the type within the context of a local classification system is a useful initial step. Information on the dominant tree species and the most abundantly reproducing tree species is useful in forested areas. Data from the initial measurements on trampling lanes can be used to summarize the composition of the groundcover (see, for examples, Cole 1985, in press). A brief description of the physiognomy of the vegetation is also important (for example, density of the overstory, height of understory layers and, particularly, growth form(s) of the groundcover). If the plots are located on a slope, provide a measure of slope. Finally, a description of soil (including the organic horizons), landform and drainage characteristics can also provide information useful in interpreting responses to trampling.

TIME REQUIREMENTS

In some cases it will take a considerable amount of time to find suitable locations for the trampling lanes. This time requirement, along with that for transportation to and from plots can be highly variable. Time requirements for set-up, treatment and measurements should be more consistent. My experience suggests the following estimates of time spent for four replications in a single vegetation type:

Set-up and all initial measurements	8-12 hours
Trampling treatments and height measurements	5-6 hours
Cover measurements two weeks after trampling	2-3 hours
All measurements one year after trampling	6-8 hours

Variations in time reflect the efficiency of different observers and, particularly, the complexity of vegetation composition. Highly resistant vegetation types that must receive more than 500 passes will require considerably more time during the trampling stage. Estimates assume familiarity with the constituent species. Even assuming some time spent in transportation, once locations have been found and familiarity with techniques and vegetation has been gained, each vegetation type should require no more than two or three full days of work, followed by a half day two weeks later and a full day one year later.

EQUIPMENT REQUIREMENTS

Tape measure

30 cm by 50 cm quadrat

Pin frame, with 5 pins (3 mm in diameter, located 5 cm apart, with markings at 2.5 cm, 5 cm, 10 cm, 15 cm, 20 cm, etc.)

Lug-soled boots for walking

Pack with weights (if required to increase weight to at least 175 lb)

A means of delineating lanes (I have used 80 lengths of PVC pipe, 20-50 cm tall and 2-3 cm in diameter)

Mallet (optional--for pounding in stakes)

String (optional--to enclose lanes to facilitate trampling and measuring)

Mechanical counter (optional--to help "remember" how many passes have been made)

CONCLUSIONS

This procedure should meet the objectives established. It can be conducted in a manner that will produce comparable results in different places by different investigators. It will provide measures of response to common levels of trampling, the level of trampling required to cause substantial deterioration, and the amount of recovery that can occur within one year. Equipment requirements are minimal, as is the time requirement. Each vegetation type can be examined in no more than a week's work (although the time is dispersed over a one year period). Space requirements are also small; about 40 m^2 are required for each vegetation type.

LITERATURE CITED

Cole, David N. 1985. Recreational trampling effects on six habitat types in western Montana. Res. Pap. INT-350. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 43 p.

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